A STUDY ON ROLE OF OPTICAL COHERENCE TOMOGRAPHY IN HIGH MYOPIA

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DISSERTATION FOR

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CERTIFICATE

This is to certify that **Dr.AMUDHA.A,** Post Graduate student in M.S Ophthalmology, at Regional Institute of Ophthalmology and Government Ophthalmic hospital attached to Madras Medical College, Chennai, carried out this dissertation on **"STUDY ON ROLE OF OPTICAL COHERENCE TOMOGRAPHY IN HIGH MYOPIA"** under my direct guidance and supervision during the period from May 2006 to March 2009.

This dissertation is submitted to the TamilNadu Dr.MGR Medical University, Chennai in partial fulfillment of award of M.S. Degree in Ophthalmology.

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I, **Dr. AMUDHA.A,** solemnly declare that the dissertation titled **"STUDY ON ROLE OF OPTICAL COHERENCE TOMOGRAPHY IN HIGH MYOPIA"** has been prepared by me. This is submitted to The Tamil Nadu Dr. M.G.R. Medical University, Chennai, in partial fulfillment of the requirement for the award of M.S. Ophthalmology, degree Examination to be held in March 2009.

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INTRODUCTION:

Starting from white-light interferometry for in vivo ocular eye measurements imaging of biological tissue, especially of the human eye, was investigated by multiple groups worldwide. First devised in 1990 by Naohiro Tanno, then a professor at Yamagata University, and in 1991 by Huang et al., optical coherence tomography (OCT) with micrometer resolution and cross-sectional imaging capabilities has become a prominent biomedical tissue-imaging technique; it is particularly suited to ophthalmic applications and other tissue imaging requiring micrometer resolution and millimeter penetration depth.

OCT has also been used for various art conservation projects, where it is used to analyze different layers in a painting. OCT has critical advantages over other medical imaging systems. Medical ultrasonography, magnetic resonance imaging (MRI) and confocal microscopy are not suited to morphological tissue imaging: the first two have poor resolution; the last lacks millimeter penetration depth. OCT is based on low-coherence interferometry.

In conventional interferometry with long coherence length (laser interferometry), interference of light occurs over a distance of meters. In OCT, this interference is shortened to a distance of micrometres,

thanks to the use of broadband light sources (sources that can emit light over a broad range of frequencies). Light with broad bandwidths can be generated by using superluminescent diodes (superbright LEDs) or lasers with extremely short pulses (femtosecond lasers). White light is also a broadband source with lower powers. The posterior pole of highly myopic eyes is a unique environment in which chorioretinal stretching and atrophy from marked scleral concavity and staphyloma are often associated with persistent vitreoretinal adhesions. The formation of macular hole and posterior retinal detachment are well known advanced consequences of this unstable condition. The early stages of such damage, however, are barely detectable by common diagnostic tools because of the peculiar fundus picture of high myopia and are apparent only using the high imaging resolution of OCT. In cases of vitroretinal adhesions vitrectomy with release of vitreoretinal traction without fluid/gas exchange can be done and followed with OCT.

PRINCIPLE OF OPTICAL COHERENCE TOMOGRAPHY:

Optical coherence tomography is based on the principle of Michelson interferometry. Low coherence infra red light coupled to a fiber-optic travels to a beam-splitter and is directed through the ocular media to the retina and to the reference mirror respectively. Light passing through the eye is reflected by structures in different retinal tissue layers. The distance between the beam splitter and the reference mirror is continuously varied. When the distance between the light source and the retinal tissue is equal to the distance between the light source and the reference mirror, the reflected light from the retinal tissue and reference mirror interacts to produce a interference pattern. The interference pattern is detected and then processed into a signal.

The signal is analogous to that obtained by A-scan ultrasonography using light as a source rather than sound. A two-dimensional image is built as the light source is moved across the retina. The image is in the form of a series of stacked and aligned A-scans, which produces a two-dimensional cross-sectional retinal image that resembles that of a histology. Digital processing algins the A-scans to correct for eye motion. Digital smoothing techniques are used to further improve the signal-to-noise ratio.

NORMAL OCT SCAN:

On a normal 10 mm horizontal scan passing through the fovea, one can clearly demarcate two major landmarks, namely, the optic disc and fovea.

The optic disc is seen towards the right of the tomogram and can be easily identified by its contour. The central depression represents the optic head cup and the stalk continuing behind is the anterior part of the optic nerve. The fovea is seen towards the left of the tomogram and can be easily identified by characteristic thinning of the retinal layers. The vitreous anterior to the retina is non-reflective and is seen as a dark space. The interface between the non- reflective vitreous and backscattering retinal layers is the vitreoretinal interface.

Retinal morphology and the macular OCT imaging correlate well, with alignment of areas of high and low reflectively to specific retinal and choroidal elements.

Resolution of retinal structures by OCT depends in the contrast in relative in reflectivity of adjacent structures.

The nerve fiber layer and ganglion cell layers are reflective, and are seen as bright colors on the false color map. The nuclear layer appear

hyporeflective, while the interconnecting plexiform layers and axonal layers are reflective hyper-reflective. Typically, the photoreceptor appear slightly hyporeflective compared with the outer retinal layers. The retinal pigment epithelium/ choriocapillaris complex is seen as hyper-reflective band. The retinal blood vessels within the neurosensory retina show backscatter and also cast a shadow behind. The choroids is also highly reflective, although it is frequently not well resolved because of light reflection by the overlying retinal pigment epithelium.

OPTICAL COHERENCE TOMOGRAPHY INTERPRETATION

An OCT image can have two modes of interpretation: objective and subjective. For an accurate interpretation, one needs to combine both these modalities. The purpose of OCT is to detect abnormalities in the retina, in terms of thickness, and morphology, and reflectively.

Optical coherence tomography reading must be done in two stages:

1. Qualitative and quantitative analysis

2. Deduction and synthesis

The analysis study can be further divided into:

Qualitative analysis:

1. Morphological study:

Morphological variations: overall retinal structural changes, changes in retinal outline, intraretinal structural changes and the morphological changes in the posterior layers.

2. Reflectively study

Hyper-reflectivity, hypo-reflectively, and shadow areas.

Quantitative analysis:

Thickness, volumetry and surface mapping. Deductive and synthetic study is performed comparing all the analytical data, the results of the clinical examination and all the other available data.

The OCT software offers the protocols for both qualitative as well as quantitative estimation.

Qualitative Analysis:

Various image modification protocol can be used for qualitative analysis.

1. Normalize:

This protocol is used to eliminate background noise and to use the whole color scale in the processed scan image. This function normalizes scan images with respect to noise and signal strength. In other words, when one applies this function to scan images made with different noise or signal strength, the resulting images appear equally "bright", i.e. have the same range of color.

2. Align:

This protocol is used to correct the data for effects due to patient motion in the axial direction. Slight movements of the head toward and away from the instrument cause the scan image to shift vertically, resulting in low frequency "wiggles". (This also happens if the scan beam is not perpendicular to the retina over the whole scan). To correct for this movement, this algorithm compares each of the longitudinal samples (A-scans) in the data set with its neighbor in a process called correlation. In effect, it slides A-scan 2 in relation to A-scan 1 until the data align. Then it slides A-scan 3 in relation to the now- aligned A-scan 2, and so on until all A-scans are aligned.

3. **Gaussian and median smoothing:**

The two smoothing functions average out noise and blend the colors of the scan image. Smoothing may be useful to appreciate more fully the large-scale features in the data. However, some small details may be lost.

Gaussian smoothing works by calculating a moving average of signal values in a 3x3 region. It weighs the signal values according to a Gaussian function, such that the outer points in the region are weighted less than the center point.

Median smoothing is similar to Gaussian smoothing, except that it uses the median value of the 3×3 region(i.e the middle value when ordered by size) instead of the moving average value weighted by location. The advantage of median smoothing is that it removes noise while preserving small details in the data.

MORPHOLOGICAL STUDY:

Deformation of Retina:

a. Concavity:

In cases of high myopia and posterior staphyloma in myopia, OCT reveals the presence of pronounced concavity, which can become less evident if the scan is processed using the alignment function.

b. Convexity:

Convexity is usually observed in the cup shaped detachment of the retinal pigment epithelium and subretinal cysts.

Deformation of retinal profile:

a. Disappearance of the foveal depression:

This is a sign of clinically significant macular edema.

b. Epiretinal membrane:

It may be separate from the retina, in contact with it, or adhered to it and may cause folds of retinal surface..

c. Macular pseudo holes and lamellar holes

d. Macular hole:

The OCT helps in identifying and classifying macular holes, as well as determining their diameter and the extent of detachment.

Intraretinal Structural Changes:

a. Pseudohole

b. Cysts due to cystoid macular edema

c. Cotton wool spots consist of superficial hyper-reflective retinal nodules, which are in contact with superficial retinal layers in the nerve fibre layer. That are located at the margins of ischemic lesions of the nerve fibre.

d. Hard exudates occur at the margin of an edematous area and normal retina. They are hyper-reflective in an OCT scan.

Posterior Morphological Changes:

a. Retinal pigment epithelial detachments deform the posterior limit of retina on OCT scan, forming a steep angle with the choriocapillaries.

b. Serous retinal detachment of the retina protrude less, and form shallow angles with the retinal pigment epithelium.

c. Drusens produce irregularities and wavy undulations of the pigment epithelium and choriocapillaries.

d. Choroidal neovascular membrane in young or myopic patients are usually visualized as nodular rounded fusiform structure located in front of the retinal pigment epithelium.This is also true in cases of early neovascular age related macular degeneration. They may be associated with edema or serous retinal detachment. When choroidal neovascular membranes have had several weeks or months to develop they are much more difficult to detect and may appear as thickening of the retinal pigment epithelium. Occult choroidal neovascular membranes are difficult to identify.

Reflective Study:

When pathology is present, reflectivity may be increased or decreased, or a shadow zone may be observed on an OCT scan. Vertical structures, such as photoreceptors, are less reflective than horizontal structures, such as nerve fibers.

Shadow areas:

An area of dense, hyper-reflective tissue produces a screen that may be complete or incomplete, thereby creating a shadow area on OCT scan that conceals the elements lying behind it.

Anterior shadow and screen effects:

- Hemorrhage
- Exudates
- Retinal vessel(normal)

Posterior shadow and screen effects:

- Retinal scars
- Pigment epithelial hypertrophy/hyperplasia
- Pigment accumulation
- Choroidal nevi

Quantitative Analysis:

a. Retinal thickness/volume:

This analysis protocol obtains two circular maps for each eye that depicts thickness and volume of retina. It can be displayed either as retinal thickness or retinal volume.

b. Retinal Thickness/Volume Tabular:

It obtains not only for all the output of retinal thickness/volume analysis, but also a data table that includes thickness and volume quadrant averages, ratios and differences among the quadrants and between the eyes.

c. **Retinal Thickness/Volume Change:**

This analysis protocol helps to assess the changes in retinal thickness or volume between examinations.

OCT SCAN PROTOCOLS FOR MACULA

The stratus OCT-3 offers various scan acquisition protocols for examination. To get the most accurate and meaningful information, one

needs to apply the appropriate protocol. Scan protocols suitable for macula are:

Line scan:

This scan protocol gives an option of multiple line scans without returning to the main window. The default angle is 0˚ and the nasal position is defined as zero degree. By default, the length of the line scan is 5mm.However, the length of the line scan and angle can be altered. As the length scan increases, the resolution decreases. Multiple scans of different parameters can be acquired using this protocol.

Radial scan:

This scan protocol consists of 6 to 24 equally spaced line scan that can be varied in size and parameters. All the lines pass through a central common axis. The default setting has 6 lines of 6 mm length. Adjusting the size of aiming circle can change the macular scan and retinal thickness/ volume analysis.

Macular thickness map:

This scan protocol is similar to radial lines except that the aiming circle has a fixed diameter of 6 mm. This acquisition protocol helps in measuring the macular thickness.

Fast Macular Thickness Map:

This scan protocol is designed for use with retinal thickness analysis. When performed in both eyes, it can be used for comparative retinal thickness/ volume analysis. It is a quick protocol that takes only 1.92 seconds to acquire six scans of 6 mm length each. The size and number of scan is fixed and cannot be altered.

Raster lines:

This scan protocol provides an option of acquiring a series of lines lines that parallel, equally spaced and are 6-24 in number. These multiple line scans are placed over a rectangular region, the area of which can be adjusted to cover the entire area of pathology. This protocol is especially useful in disease conditions like choroidal neovascular membranes, where scans at multiple levels are required. The default setting has 3 mm square with 6 lines.

Repeat:

Repeat protocols enables one to repeat any of the previously saved protocols using the same set of parameters that include scan size, angle, placement of fixation light emitting diode and landmark. This protocol is especially helpful when one is monitoring retinal changes. No parameter except placement can be changed. The landmark can be placed on the point of reference. This helps in reproducibility during repeat scan. The previous image can be displayed for accurate placement of landmark.

ULTRA HIGH RESOLUTION OPTICAL COHERENCE TOMOGRAPHY

Standard ophthalmic OCT provides more detailed structural information than any other ophthalmic diagnostic technique. Despite the promising and clinically valuable results of these OCT studies, the axial resolution and performance of standard clinical ophthalmic OCT technology can be significantly improved.

Drexler and Fujimoto developed a clinically viable ultra high resolution OCT based on femtosecond titanium- sapphire laser. It enables all of the major layers to be visualized noninvasively with axial resolution of approximately 3 microns.

OPTICAL COHERENCE TOMOGRAPHY AND SCANNING LASER OPHTHALMOSCOPE TECHNOLOGY

OCT imaging requires a series of image processing programs. Two specific limitations are recognized.

1. Errors in A- scan image correlation and interpolation:

Cross-correlation and interpolation errors of A-scan increase as the scan lengths increase from 3 to 10 mm, making image quality less reliable.

2. Precise anatomic localization of the OCT image from the red-free image:

The anatomic localization is compromised because the red-free image depicting the position of the OCT trace is not pixel linked.

A new device is being developed to create OCT B-scan images and use simultaneous red-free Scanning laser ophthalmoscope pixel linked images for precise OCT image localization. The OCT B-scan images are created by horizontal scanning (x-y) in the ophthalmoscopic plane, at increasing depths. This technology also permits accumulation of

information from entire plane of tissue at varying depths, creating a new image format called C- scan.

Numerous C-scan images can be computer processed into 3-D OCT images that permit volumetric and linear measurements. The new technology utilizes a beam splitter at the light source to create two channels. One channel uses conventional SLO to create red- free images, while the other channel is used to create simultaneous OCT images. Since the images are pixel linked, precise anatomic localization of OCT image is possible.

PREVALENCE OF MYOPIA

Myopia is reaching epidemic proportions, especially in Asia, due to urbanisation and increased screen and text-based activity throughout all aspects o our daily lives.

The prevalence of myopia in Asia is as high as 70-90%. The number of myopes in the world is estimated to grow from 1.6 billion now to a staggering 2.5 billion by 2020.

If left untreated and uncorrected, myopia can adversely affect a child's education and learning ability. Visual impairment due to uncorrected refractive error (<6/18 in adults and <6/12 in children) has been estimated to affect as many as 200 to 250 million people worldwide.

Prevalence of myopia varies with age, sex, race, country, ethnicity occupation, environment and other factors.

At three periods of development the prevalence of myopia shows marked changes.

From the premature period to newborn there is a sharp decrease. From the newborn period to the age of six months, the reduction is to a lesser extend. From five to twenty years there is a sharp rise. Some five to

ten years after this gradual decline is seen. There is no significant difference in the refractive error between boys and girls.

OPTICS OF THE EYE

Emmetropia is the condition in which the parallel beam of light come to focus on the retina, with the eye at rest. At birth, the average axial length is 18mm,and an infant eye undergoes rapid growth in the first few years of life to reach an axial length of 23mm .

Ametropia is the condition in which the incident parallel rays of light do not come to a focus upon the light sensitive layer of the retina.

TYPES OF AMETROPIA:

Axial ametropia:

Abnormal increase in the length of eyeball(an 1mm elongation produces approximately 3D of myopia)

Curvature ametropia:

Abnormal curvature of the refracting surfaces either the cornea or lens(1mm change in the radius of curvature of the cornea produces a 6.00D refractive error.

Index ametropia:

Abnormal refractive indices of the media

MYOPIA

DEFINITION:

Myopia is a form of refractive error wherein parallel rays of light come to focus in front in front of the sensory layer of the retina when eye is at rest.

CLASSIFICATION OF MYOPIA

Etiological classification:

Axial myopia:

This the commonest type seen. It is due to an increase in the anteroposterior diameter of the eye. Every 1mm increase will cause 3.00D increase in myopia.

Curvature myopia:

It is due to an increase in the curvature of the cornea or the surfaces of the lens.

Index myopia:

Occurs due to change in the refractive index of the media. example-myopia seen associated with cataract and diabetes.

CLINICAL CLASSIFICATION

Clinically there are two types of myopia. They are simple myopias and pathological myopias.

SIMPLE MYOPIA:

It is the physiological variant of the normal. This a condition of limited progression. Simple myopia are of two types.

Physiologic myopia:

The ocular components are all within the normal distribution range . Postnatal development is normal. There is no correlation between the total refractive error and a normal axial diameter. The heredity is multifactorial.

Myopia of -3.00 dioptres and less is physiologic.

Intermediate myopia:

There is increased expansion of posterior segment of globe. The entire posterior segment is involved. Generalised spreading and thinning of retinal pigment epithelium seen. Myopia upto -8.00 dioptre associated with various fundus changes can be considered intermediate.

Pathological myopia:

Also called as malignant myopia. Determined by hereditary and postnatal factors. There is excessive axial elongation of the eye and a number of ocular complications. Myopia of -6.00 dioptres or more is considered is pathological.

PATHOGENESIS

Pathological myopia is characterized by degenerative changes occurring particularly in the posterior segment of a highly myopic eye , often associated associated with lengthening of the anteroposterior axis of the globe. It denotes an extreme axial elongation in which degenerative as well as vascular alterations are superimposed.

The most common form of pathological myopia is the isolated developmental form, where as in simple myopia the myopic tendency is restrained after puberty.

In developmental myopia the near sightedness may increase even more rapidly during adolescence and the axial enlargement may even slowly increase during adulthood into the 40s and 50s , with the eventual genesis of atrophic and degenerative intraocular changes leading to visual loss and possibly blindness.

Congenital axial pathologic myopia may also occur .This frequently is associated with other congenital defects such as colobomas and anomalies of pigmentation of the retina or choroids. The most common associated fundus conditions resemble partial albinism.

Varying degrees of myopia commonly are associated with ROP,micropthalmia,microcornea,microphakia,buphthalmos,tapeto-retinal dystrophies and down syndrome.

INHERITANCE:

The pathogenesis of pathological myopia remains unclear. Several loci for high grade myopia have been mapped- MYP1on chromosome Xq28, MYP2 on chromosome 18p, MYP3 on chromosome 12q, MYP4

on chromosome 7q, MYP5 on chromosome 17q. Myopia of severe degree was transmitted through 4 generation in the family reported by Francois (1961).

Myopia is, in a sense, a metric character, Variation in many components of the eye contributes to its refractive capacity. Some myopia, perhaps most, is multifactorial in causation. Both autosomal dominant and autosomal recessive inheritance has been suggested.

OCULAR CHANGES IN PATHOLOGICAL

MYOPIA:

Clinically, a severe myopic eye generally appears large and prominent. The gross appearance of the highly myopic eye is egg or pear shaped and significantly enlarged. The cornea may be abnormally flat, the anterior chamber is somewhat deeper than normal and the ciliary muscles are atrophic. The ciliary muscle in a person with high myopia often is smaller than normal, probably because the myopic individual requires the less use of the muscles of accommodation.

CHANGES IN POSTERIOR SEGMENT:

The major changes are confined almost to the posterior pole. The first to correlate the histologic changes in myopia with the ophthalmoscopic changes was Von Graefe. These changes are summarized as follows:

1. **Scleral changes-** posterior enlargement of the globe and thinning of the sclera at the posterior pole with scleral ectasia and posterior staphyloma.

2. **Changes in the epipapillary and the peripapillary region-** oblique entrance of the optic nerve, tilted disc, myopic crescent, nasal supertraction.

3. **Changes in the choroid and retina-** atrophy and thinning, particularly affecting the posterior pole and the periphery. These changes include atrophy and/ or proliferation of the pigment epithelium, formation of the Foster Fuchs spot at the macula, retinal microcystoid degeneration, and occasional peripheral retinal break formation and subsequent detachment.

4. **Degenerative changes in the vitreous.**

1. SCLERAL CHANGES

Scleral thinning with occasional formation of a posterior staphyloma of the sclera is common. The staphyloma may surround the optic nerve head and extend temporally to involve the posterior pole and sometimes even the equator. The normal sclera progressively thickens from the equator backward, becoming thickest at the posterior pole. In a globe with severe myopia the opposite situation occurs; the sclera becomes progressively thinner posteriorly in the peripapillary region. When present, a staphyloma is lined by a thin atrophic choroids, and the margins of the staphyloma usually reveal a relatively abrupt edge.

Types of Posterior Staphyloma:

Mainly five primary varieties are seen. Their features are as follows

TYPE I:

Here tessellation and pallor will extend over a horizontal elliptical area. It is seen nasal to disc margin. commonest type seen.

TYPE II:

Called as macular staphlyoma. Extends from the optic nerve to the temporal aspect of macula.

TYPE III:

Least common type. Involves a well circumscribed area around the disc called as peripapillary staphyloma.

TYPE IV:

Nasal or inferonasal aspect of the optic nerve head is involved There is associated inversion of the retinal vessels. Hence also called as inverse myopia.

TYPE V:

Usually shallow and involves an elliptical zone below disc. Commonly considered as a form of choroidal coloboma.

2. CHANGES IN THE EPIPAPILLARY AND PERIPAPILLARY REGIONS:

Ophthalmoscopically the optic nerve in acquired myopia is ovoid with the long axis in vertical direction. Myopic degeneration usually makes their initial appearance in the crescent margin. In severe cases entire peripapillary area can be involved. In the typical myopic eye the disc appear tilted with the temporal side flattened which is surrounded by a concentric or crescent shaped area or areas of relative fundus depigmentation.

The myopic crescent invariably occurs in later years in patients with myopia greater than 6D. The sclera is visible because of an absence of pigment epithelium and choroid, both of which fail to extend to the temporary margin of the disc. The crescent of acquired myopia are located temporally in approximately 80% of cases. In 10% of cases, the crescent may extend to become annular, surrounding the entire disc, sometimes even spreading to include a large area of the fundus with envelopment of the macular area. In rare instances the myopic crescent is situated on the nasal side of the disc (inverse crescent).

3. CHANGES IN THE CHOROID AND RETINA

Atrophy of the choroids occurring predominantly near the posterior pole is almost consistent feature of severe pathological myopia. Initially the retinal pigment epithelium becomes attenuated and the choroidal vessels become visible. Splits may develop in Bruch's membrane. These form clefts (lacquer cracks or lightening figures (German Lacksprunge and Blitzfiguren), which seem to branch and have a reticular appearance.

During the course of pathological myopia choroidal haemorrhage are seen. Usually seen in the macula. Can be isolated or along with lacquer crack formation. The plane is between retinal pigment epithelium and lamina vitrea.

LACQUER CRACKS

The ruptures of the lamina vitrea is seen as lacquer cracks. This appears as yellow white lines across posterior pole irregular in caliber. Usually multiple and are horizontally oriented. They may also show criss cross pattern.

These lesions are traversed by large choroidal vessels posteriorly. The inner layer of the retina is normal. Associated with concentric contraction of the field. Acquired yellow blue colour deficiency is also

seen. If they are in macula, central vision is impaired. Along these lesions focal areas of chorioretinal atrophy are seen.

FORSTER FUCH'S SPOTS:

Through the defect in lamina vitrea proliferation of choroidal fibrovascular tissues occurs. Thus a firm adhesion is seen between choroids and retina. This fibrovascular tissue can cause haemorrhage. There is marked proliferation of overlying retinal pigment epithelium. This forms a unique well defined, elevated, black lesion at the posterior pole of the eye called Forster Fuchs spot.

DEGENERATIONS OF THE PERIPHERAL RETINA:

Lattice degeneration:

Most common lesion, most frequently located between the equator and the posterior border of vitreous base. Limbus parallel sharply demarcated and circumferentially oriented spindle shaped areas of retinal thinning and abnormality in the adjacent vitreous. Important features include an arborizing network of fine white lines that are often continuous with the blood vessels, alteration of pigment epithelium, with frequent accumulation along the interlacing white line, round punched out area of retinal thinning or hole formation; small yellow- white particles

on the surface of the lesion, at the margin and in the adjacent vitreous, liquefaction of the underlying vitreous, exaggerated vitreous attachment to the margin of the lesion and prone for tear to develop along the posterior margin of retinal thinning. These lesions enlarge circumferentially and new lesions also form. These lesions are usually bilateral and are often located in the superior temporal quadrant.

Fluorescein angiography shows nonperfusion within the lesion, especially when the vessels have turned white.

SNAILTRACK DEGENERATION:

Tiny yellow- white flecks which gives the peripheral retina a white frost like appearance. Usually longer than islands of lattice. Vitreous traction at the posterior border of the lesion is seldom present (so the tractional U tear rarely occurs). May result in hole formation resulting in retinal detachment. Histological studies show that the glistening particle represents a microglial cell containing lipoid or lipoprotein material.

RETINAL HOLE:

In a more advanced tropic lesion a round complete retinal break without detachable flap or operculum occurs. These lesions are commonly found in the anterior zone, usually in an area of relatively

normal retina. Exaggerated vitreous attachment and proliferative reaction are distinctly absent.

CYSTOID DEGENERATION:

Foamy, white thickening of the retina at and just posterior to the ora serrata. Best seen on depression ophthalmoscopy as multiple red dots. Inner wall of single cyst may be absent or broken giving the appearance of retinal hole. This is a pseudohole since the outer wall of the cyst is intact.

Another type of cystoid degeneration is the reticular cystoid degeneration of the peripheral retina, is almost invariably located posterior to and continuous with the typical cystoid degeneration. Retinal cystoid degeneration most frequently occurs in the infero-temporal quadrant.

PAVINGSTONE DEGENERATION:

It is characterized by one or more discrete rounded foci of depigmentation and retinal thinning located between the ora serrata and the equator. The lesions are yellow white, frequently reveals the underlying choroidal vessels and often has a pigmented margin.

The lesion is round in shape and is one to several disc diameters in size. Clusters these rounded foci may merge to form larger lesions with scalloped margin and incomplete pigmented septum.

Histologically characterized by loss of retinal pigment epithelium and the outer retina with adhesion of the inner retina to the Bruch's membrane .It does not predispose to retinal breaks.

CHORIORETINAL DEGENERATION:

This condition always extends round the fundus periphery. It begins and is more severe in the retina adjacent to the ora serrata. It spreads posteriorly and merges into the normal healthy retina without definitive demarcation. Chorioretinal degeneration is frequently associated with cystoid retinal degeneration, both conditions more or less occupying the same area. The ophthalmoscopic appearance of chorio-retinal degeneration can be graded as mild, moderate or severe.

These changes are always severe adjacent to the ora serrata and mildest further posteriorly . Peripheral chorio-retinal degeneration begins to appear in the forth decade of life and increase severely with age.

CHORIO-RETINAL ATROPHY:

Is characterized by discrete areas of retinal and choroidal thinning. Pigment proliferation, and migration of the pigment around the edges of the lesion with the centre pale and dirty grey. Atrophy of the inner choroidal layer clearly expose the large choroidal vessels.

PIGMENTARY DEGENERATION:

Pigmentation may vary from diffuse thickening of the fundus to the presence of large discrete clumps. Pigment may be found in scattered clumps or granules or as localized clumps or may be diffusely distributed. Pigmentary degeneration has a tendency towards bilaterality and apparently no sex preference. It occurs along with white without pressure or lattice degeneration or associated with silent breaks.

RETINOSCHISIS:

This condition is a splitting of the neural layers of the retina which generally occurs in the outer plexiform layer. Typical degenerative retinoschisis is a more extensive tropic process and presents as a round or oval area of retinal splitting with a smooth fusiform elevation of the inner layer and its blood vessels, It may occur in any meridian but is more common in the infero- temporal quadrant bordering the ora.

Reticular degenerative schisis is round or ovoid with bullous elevation of the extremely thin inner layer and with an irregular pitted outer layer. Most commonly found in the supero- temporal quadrant.

WHITE WITHOUT PRESSURE:

Circumferentially arranged geographic white or grey areas are seen. They may be flat or elevated. The common site is inferior quadrant, posterior to the equator. The surface is covered by glistening yellow white dots and fine lines.

The cause is not known, but it is assumed to be a manifestation of vitreous traction or a weakness in the extracelluar substance located between the pigment epithelium and the photoreceptors.

WHITE WITH PRESSURE:

Usually found in areas of lattice, snail track degeneration and outer layer of acquired retinoschisis. It has a golden iridescent quality during scleral depression ophthalmoscopy. It is a benign condition and is not associated with peripheral retinal breaks.

DEGENERATIVE CHANGES IN THE VITREOUS:

Vitreous changes including liquefaction, microfibrillar degeneration and formation of opacities and floaters (muscae volitantes) may occur. Posterior detachment of the vitreous commonly occurs, probably because of stretching of the enlarged globe, leaving a gap between the posterior vitreous and the posterior vitreous and the posterior pole of the eye.

The reflex of weiss is a concentric, finely striated reflex on the nasal side of the optic nerve head that occurs in advanced myopia and probably corresponds to a focus of posterior detachment of the vitreous

COMPLICATIONS:

- Rhegmatogenous retinal detachment
- Choroidal thromboses and haemorrhage
- Cataract
- Severe visual impairment
- Chronic simple glaucoma

EVALUATION OF HIGH MYOPIA

1. Visual acuity

2. Direct ophthlamoscope

3. Slitlamp biomicroscopy with 90D examination

4. Indirect ophthalmoscope

5. A scan

6. B scan

7. Fundus fluorescein angiography

8. Indocyanine green angiography

9. Optical coherence tomography- OCT with cross-sectional images of retinal structure greatly facilitates the study of the posterior vitreoretinal anatomy in eyes with high myopia and allows the detection of subtle macular changes that are otherwise undetectable and to analyse macular, foveal thickness and macular, foveal volume in high myopia.

AIM OF THE STUDY

1. To analyze the clinical features and biometric parameters in high myopia.

2. To study the posterior vitreoretinal anatomy in eyes with high myopia and detection of subtle macular changes and to calculate foveal, macular volume and foveal, macular thickness with the help of OCT.

MATERIALS AND METHODS

The study included 82 eyes of high myopia of 42 patients, who attended the out- patient department of Govt ophthalmic hospital- Egmore, Chennai.

Inclusion criteria:

1. Patients with refractive error of ≥ 6 D.

2. Eyes with pseudophakia that had or had not undergone Yag laser capsulotomy or eyes that had undergone peripheral laser or cryopexy treatment .

Exclusion criteria:

1. Myopes with Fuchs spots, active choroidal neovascularisation, acute visual loss due to retinal detachment.

2. History includes
   - Duration of refractive error
   - Age at which spectacles were first worn
   - Duration of last change of spectacles
   - Progressive loss of vision
   - Flashes and floaters
   - Any Surgical procedure done in one or both eyes.

3. Family History of Myopia

The examination included visual acuity measurements, ocular motility evaluation, retinoscopy and autorefraction under cycloplegia , anterior segment examination, fundus examination with 90D and Indirect ophthalmoscope.

IOP was measured for all the cases using Non-contact tonometry. Axial length measurement and Keratometry was done in all cases.

Then the patients were subjected to Optical coherence Tomography scan/Scanning Laser Ophthalmoscope combination imaging system (OT1).

ANALYSIS DEPENDING UPON AGE:

AGE IN YRS	NO OF PATIENTS	PERCENTAGE
0-10	3	7%
11-20	15	36%
21-30	12	28%
31-40	4	10%
41-50	7	17%
51-60	1	2%

ANALYSIS DEPENDING ON SEX:

SEX OF THE PATIENT	NO OF PATIENTS	PERCENTAGE
MALE	24	57%
FEMALE	18	43%

ANALYSIS DEPENDING ON FAMILY HISTORY:

	No. Of Cases	**Percentage**
Family History	6	14.28
No Family History	36	85.71

ANALYSIS DEPENDING ON EYES INVOLVED:

EYES INVOLVED	NO OF PATIENTS	PERCENTAGE
BILATERAL	42	100%
UNILATERAL	-	-

ANALYSIS DEPENDING ON FUNDUS CHANGES IN MYOPIA:

TOTAL NO OF EYES	NO OF EYES WITH FUNDUS CHANGES	PERCENTAGE
82	45	54%

ANALYSIS OF VARIOUS TYPES OF FUNDUS CHANGES:

FUNDUS CHANGES	NO OF EYES AFFECTED	PERCENTAGE
LATTICE	14	17%
WWP&WWOP	18	21%
POSTERIOR STAPHYLOMA	6	7%
RD	1	1%
CHORIO RETINAL DEGENERATION	4	5%
PVD	1	1%
RETINAL HOLE	1	1%

ANALYSIS DEPENDING ON IOP:

IOP RANGE	NO OF EYES	PERCENTAGE
0-10	6	7%
11-20	76	91%
21-21.5	2	2%

ANALYSIS DEPENDING ON AXIAL LENGTH:

AXIAL LENGTH	NO OF EYES	PERCENTAGE
< 25 mm	25	30%
>25 mm	59	70%

ANALYSIS ON THE REFRACTIVE ERROR:

REFRACTIVE ERROR	NO OF EYES	PERCENTAGE
6-12D	60	73%
12-18D	14	17%
>18D	8	10%

ANALYSIS OF MACULA BY OCT

FOVEAL CONTOUR	NO OF EYES	PERCENTAGE
NORMAL	77	94%
ALTERED	4	5%
MACULAR HOLE WITH VITREO MACULAR TRACTION	1	1%

ANALYSIS OF MACULAR AND FOVEAL THICKNESS BY OCT

REFRACTIVE ERROR	NO OF EYES	MEAN TOTAL MACULAR THICKNESS±SD	MEAN FOVEAL THICKNESS±SD
6-12D	60	231±27μ	174±27μ
12-18D	14	224±50μ	178±35μ
>18D	8	183±52μ	192±53μ

ANALYSIS OF MACULAR AND FOVEAL VOLUME BY OCT

REFRACTIVE ERROR	NO OF EYES	MEAN TOTAL MACULAR VOLUME ± SD	MEAN FOVEAL VOLUME ± SD
6-12D	60	1.62±0.27mm^3	0.16±0.09mm^3
12-18D	14	1.35±0.32mm^3	0.11±0.02mm^3
>18D	8	1.00±0.18mm^3	0.08±0.02mm^3

DISCUSSION

82 eyes of high myopia were studied.

Males were commonly affected. The highest incidence was seen in the age group between 11-30 year(64%). While only 6 cases had a family history of myopia, majority of the cases did not have a family history. Reduced incidence may be due to lack of awareness mainly in the low socioeconomic group.

All cases had bilateral myopia. 45 eyes had fundus changes. 18 eyes had white without pressure and 14 eyes had lattice degeneration. 6 eyes had posterior staphyloma and 4 eyes had chorioretinal degeneration. 1 eye had complete PVD,1 eye had macular hole and 1 eye had retinal detachment.

All eyes had normal intraocular pressure. 70% of the cases had axial length > 25mm. Refractive error ranges between 6 and 22 D.

Among 84 eyes 1 eye had complete PVD and 1 eye had undergone Internal procedure(PPV with membrane peeling +Endolaser +silicone laser). The two eyes were excluded and 82 eyes were studied with OCT.

The following parameters were studied :

- Posterior vitreoretinal anatomy
- Macular thickness and Foveal thickness
- Macular volume and Foveal volume

Out of 82 eyes studied 4 eyes had altered Foveal contour and 1 eye had macular hole with vitreomacular traction.

82 eyes were divided into three groups based on the refractive error and mean total macular thickness and mean foveal thickness were calculated.

60 eyes with refractive error between 6-12D had mean total macular thickness of 231±27μ, mean foveal thickness of 174±27μ, mean total macular volume of 1.62±0.27mm^3 and mean foveal volume of 0.16±0.09mm^3.

14 eyes in the range of 12-18D had mean total macular thickness of 224±50μ , mean foveal thickness of 178±35μ, mean total macular volume of 1.35±0.32mm^3 and mean foveal volume of 0.11±0.02mm^3.

8 eyes with refractive error > 18D had mean total macular thickness of 183±52μ , mean foveal thickness of 192±53μ, mean total macular volume of 1.00±0.18mm^3 and mean foveal volume of 0.08±0.02mm^3.

SUMMARY

- 82 high myopic eyes were studied.
- Males were comparatively more affected.
- Higher incidence was seen in the younger age group between 10-30 yrs.
- Majority of the patients did not have significant family history. All cases had bilateral myopia.
- 45% of the eyes showed various fundus changes like lattice, white without pressure, posterior staphyloma, PVD and RD.
- OCT was done to analyze posterior vitreoretinal anatomy, mean total macular thickness , mean foveal thickness , mean total macular volume and mean foveal volume.
- 4 eyes had altered foveal contour and 1 eye had macular hole with vitreomacular traction. **(OCT findings in myopic tractional maculopathy- Archives of ophthalmology**)
- Macular and foveal thickness and volume were analyzed by grouping the cases based on refractive error into 3 groups.

- Mean total macular thickness decreases , mean foveal thickness increases and macular volume decreases in high myopia which positively correlates with increasing refractive error**.(Assessment of macular retinal thickness and volume in normal eyes and highly myopic eyes with OCT)**

CONCLUSION

In this study retinal thickness increases in the foveal region and decreases in the macular region with smaller macular volume in high myopia which positively correlates with the increase in the refractive error.

OCT with cross sectional images of retinal structures greatly facilitates the study of posterior vitreoretinal anatomy in eyes with high myopia to allow detection of subtle macular changes that are otherwise undectable. So OCT can be done in a healthy high myopic population and in symptomatic myopic population who complains of worsening of visual function in the last 6 months to look for epiretinal and/or vitreoretinal traction and related macular damage.

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2. New investigations in Ophthalmology – Tanej Dada , Subrata Mandal

3. APPLE,DS (MOSBY) Ocular pathology-Myopia-Pathology (37-42)

4. Duke elder's practice of refraction.

5. HARJ, Jr,WH- Adlers physiology of the eye.

6. Peyman, GA Saunders, DR Goldberg: Principles and Practice of Ophthalmology vol 2.

7. Ramajit Sihota, Radhika tendon – Parsons disease of tha eye.

8. Stephen – J-Ryan- Retina

JOURNALS

1. Optical coherence tomography Findings in Myopic Traction Maculopathy- Archives of ophthalmology 2004; 122:1455-1460.

2. Myopia, Axial length and OCT characteristics of the macula in Singaporean children. –Investigative Ophthalmology and Visual science 2006;47:2773-2781.

3. Regional variations in the relationship between macular thickness measurements and myopia – Investigative Ophthalmology and Visual science 2007 ;Jan: 489(1):376-82.

4. Use of OCT to assess variations in macular retinal thickness in myopia – Investigative Ophthalmology and visual science 2005 March; 46(3):974-978.

5. Assessment of macular retinal thickness and volume in normal eyes and highly myopic eyes with third generation OCT - EYE (London) Vol 22 Issue 4 pg 551-555 (April 2008).

6. Relationship between Macular thickness measurements and myopia –Review of Ophthalmology Volume 7 , No-11, 2007 March-19.

7. Macular thickness measurements in healthy subjects with different axial lengths using OCT –RETINA –The journal of retinal and vitreous diseases April 2003, 23:2.

8. Myopic traction maculopathy –Arch SOC ESP OFTOLMOL 2007;82:65-68.

9. Vitrectomy for Myopic Tractional Maculopathy – Archives of ophthalmology 2007; 125(6): 767-772.

PROFORMA

1. Case No: Hospital No:

2. Name :

3. Age :

4. History :

- Duration of refractive error
- Age at which spectacles were first worn
- Duration of last change of spectacles
- Progressive loss of vision
- Flashes and floaters
- Any Surgical procedure done in one or both eyes.
- Family History of Myopia

5.General Examination :

6.Systemic examination :

7. Local examination :

	RE	LE
Visual acuity	:	
IOP	:	
Retinoscopy	:	
BCVA	:	
Anterior segment	:	
A-scan/Keratometry	:	
Fundus examination with 90D	:	
Indirect Ophthalmoscope	:	
OCT	Posterior vitreoretinal anatomy	
	Foveal and macular thickness	
	Foveal and macular volume	

KEY WORDS

OCT	Optical Coherence Tomography
SLO	Scanning Laser Ophthalmoscope
WWOP	White without pressure
WWP	White with pressure
RD	Retinal Detachment
PVD	Posterior vitreous detachment
LD	Lattice Degeneration
PS	Posterior Staphyloma
CRD	Chorio retinal degeneration
IOP	Intraocular pressure
PPV	Pars Plana Vitrectomy
PC	Prophylatic Cryotherapy
EL	Endolaser
SO	Silicone oil
RE	Right eye
LE	Left eye

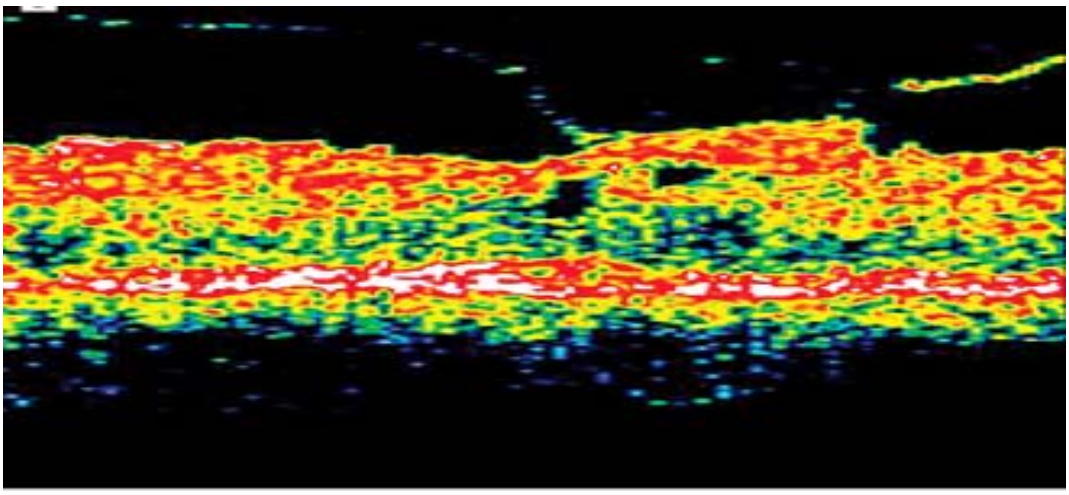
BCVA	Best corrected visual acuity
F/H	Family history
VA	Visual acuity
Ref.error	Refractive error
AL	Axial length
FT	Foveal Thickness
TMT	Total macular thickness
FV	Foveal volume
TMV	Total macular volume

LIST OF SURGERIES

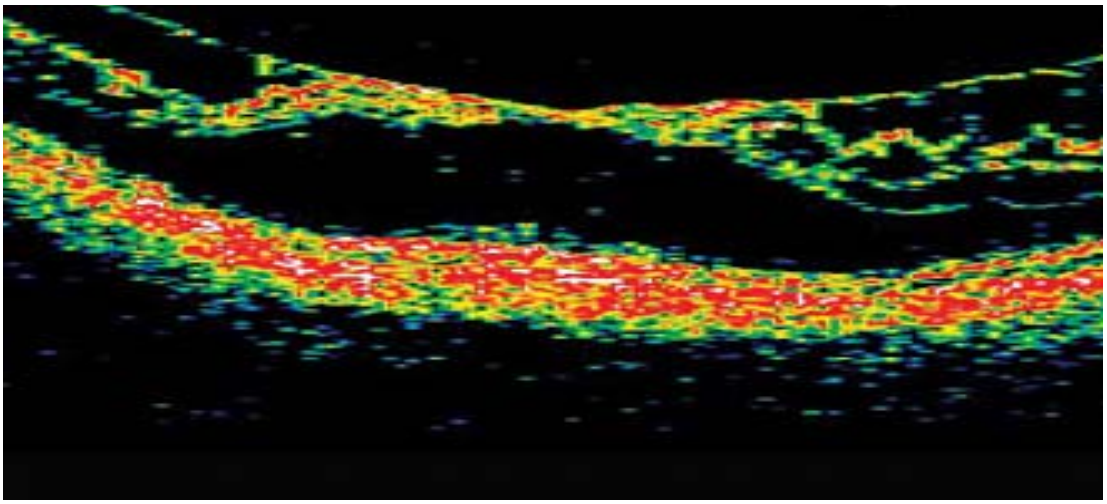
Sl No.	Name	Age	Sex	IP /OP No.	Diagnosis	Surgery
1	Kamalammal	70	F	476605	LE-Panophthalmitis	LE-Evisceration
2	Balaraman	48	M	435670	LE-Chronic Dacryocystitis	LE-DCR
3	Vargees	50	F	467780	RE-POAG	RE-Trabeculectomy
4	Balan	56	M	456349	RE-Full Thickness Corneal Tear	RE-Corneal Tear Suturing
5	Damodaran	45	M	41506	RE-Lower Lid Tear	RE-Lid Tear Sutured
6	Parvathy	52	F	465362	BE-Immature Cataract	RE-SICS with PCIOL
7	Pachiammal	60	F	45723	RE-Nuclear Cataract	RE-SICS with PCIOL
8	Penicillaiya	50	M	41276	LE-Posterior Cortical Cataract	LE-SICS with PCIOL
9	Anthoniammal	57	F	455061	LE-CACG	LE-Trabeculectomy with SICS + PCIOL
10	Mani	60	M	46231	LE-Immature Cataract	LE-SICS with PCIOL

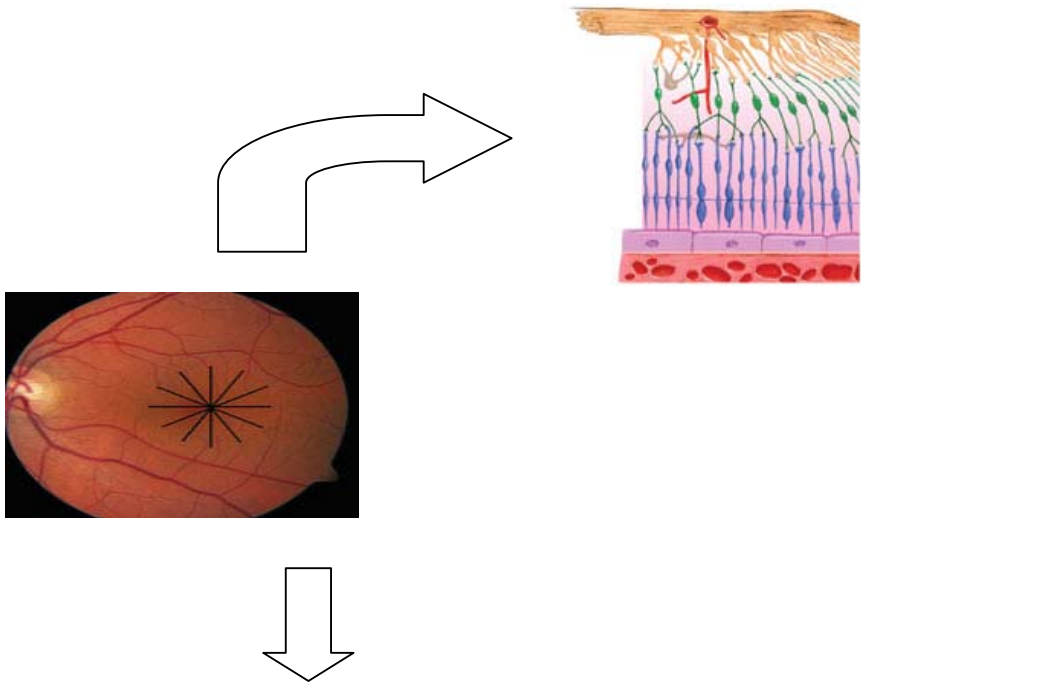
Sl No.	Name	Age	Sex	IP /OP No.	Diagnosis	Surgery
11	Kantha	60	F	412341	BE-Immature Cataract	RE-ECCE with PCIOL
12	Srinivasan	65	M	423452	RE-Mature Cataract	RE-ECCE with PCIOL
13	Balasubramani	53	M	455678	LE-Nuclear Cataract	LE-ECCE with PCIOL
14	Vallikannu	50	F	456794	RE-Chronic Dacryocystitis	RE-DCR
15	Perumal	63	M	403387	RE-Immature Cataract	RE-SICS with PCIOL
16	Prema	20	F	465389	LE-Nasal Pterygium	LE-Pterygium excision with autograft
17	Devaki	54	F	444560	RE-Immature Cataract	RE-SICS with PCIOL
18	Govindaraj	66	M	465612	RE-Chronic Dacryocystitis	RE-DCR
19	Saradha	55	F	485875	LE-Immature Cataract	LE-SICS with PCIOL
20	Jegada	35	F	456784	RE-Nasal Pterygium	RE-Pterygium Excision with Autograft

VITREOMACULAR TRACTION WITH RETINAL THICKENING



MACULAR RETINOSCHISIS

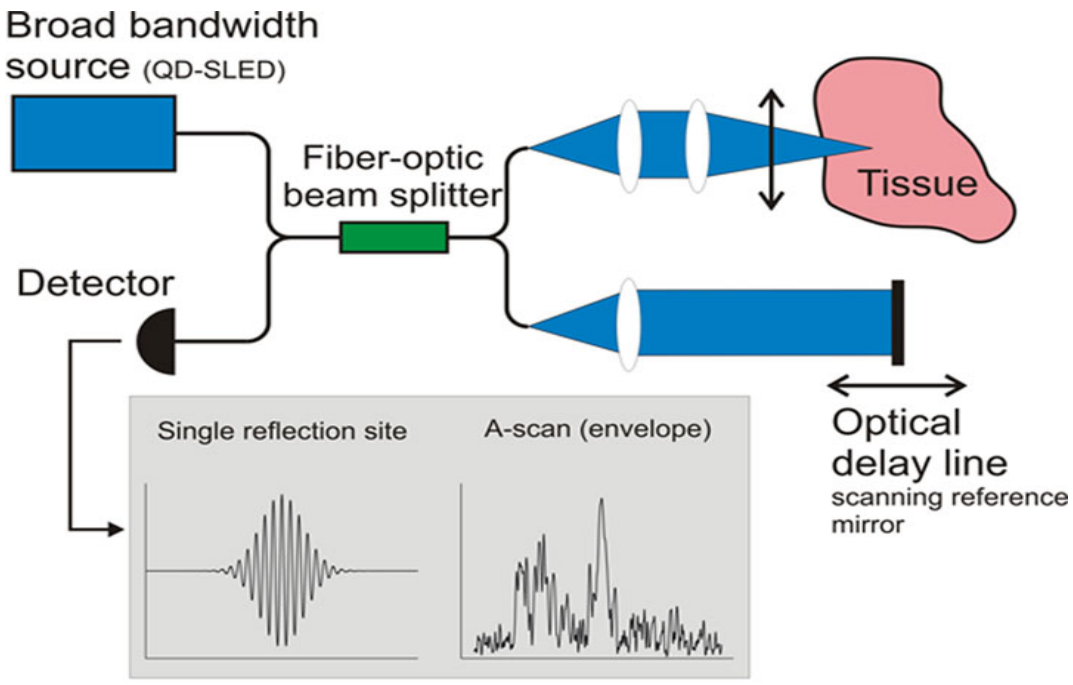


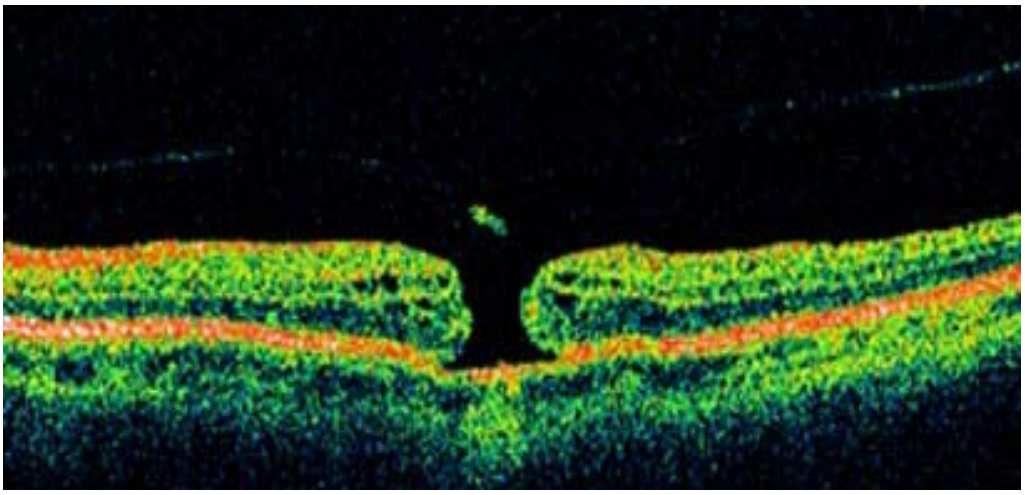


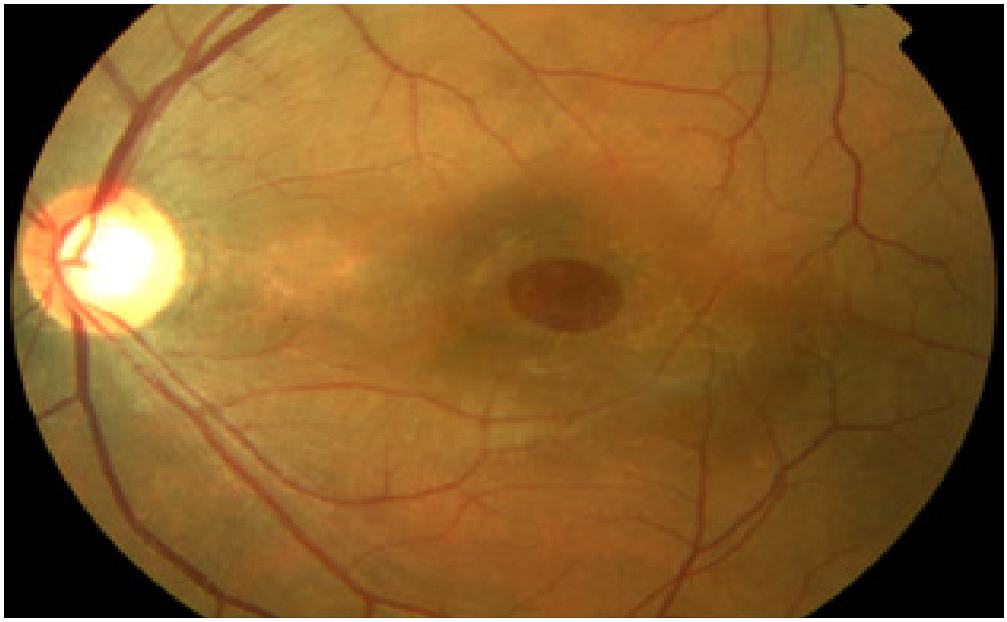
NORMAL MACULA ON OCT

OPTICAL COHERENCE TOMOGRAPHY

PRINCIPLE OF OCT

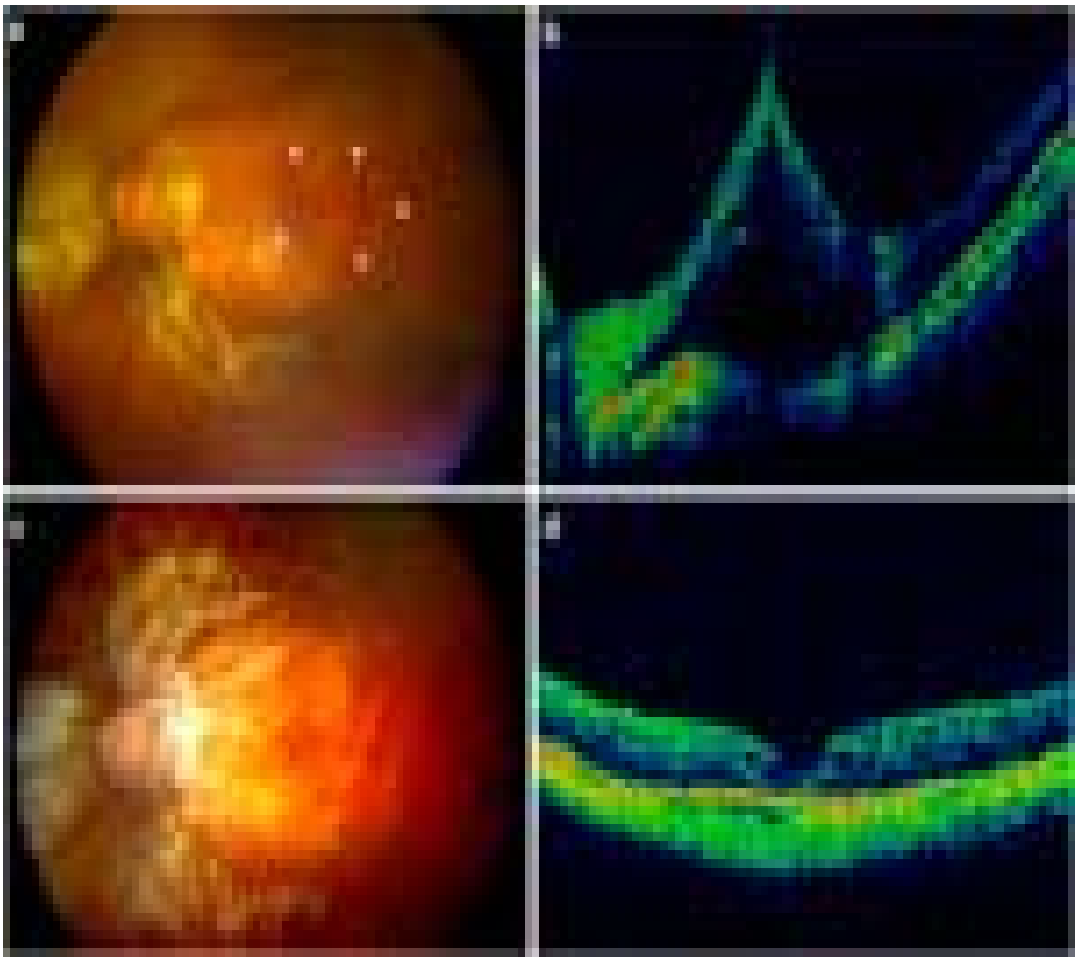


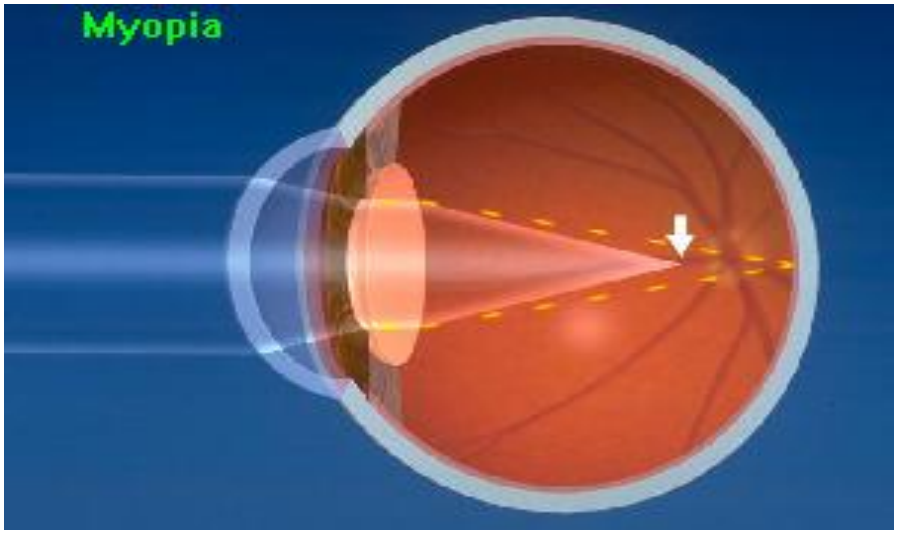




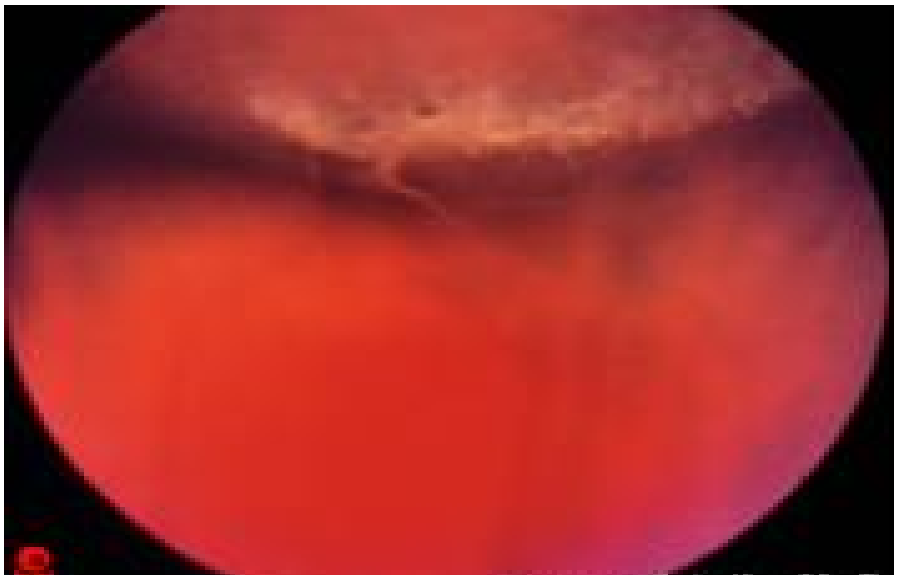
MACULAR HOLE

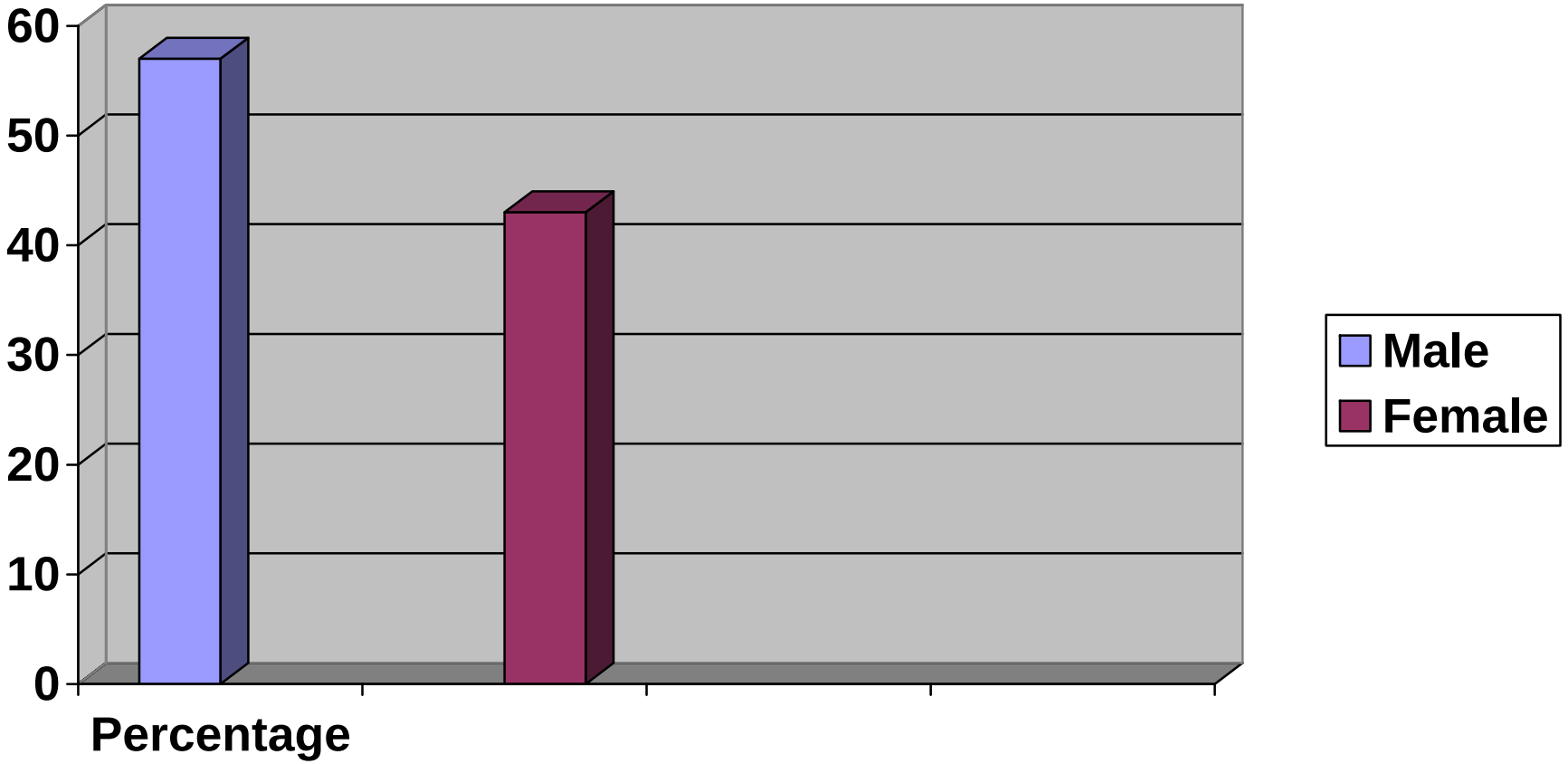
MYOPIC CHORIORETINAL DEGENERATION



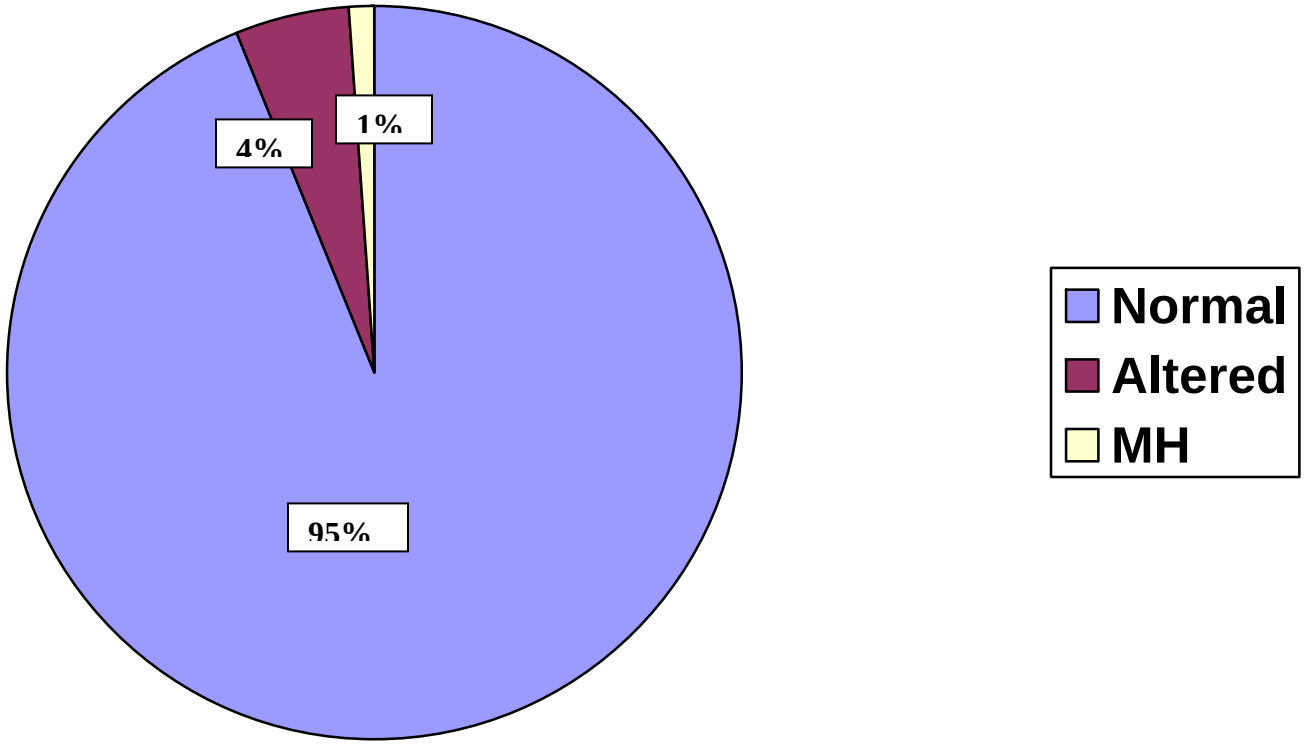


LATTICE DEGENERATION

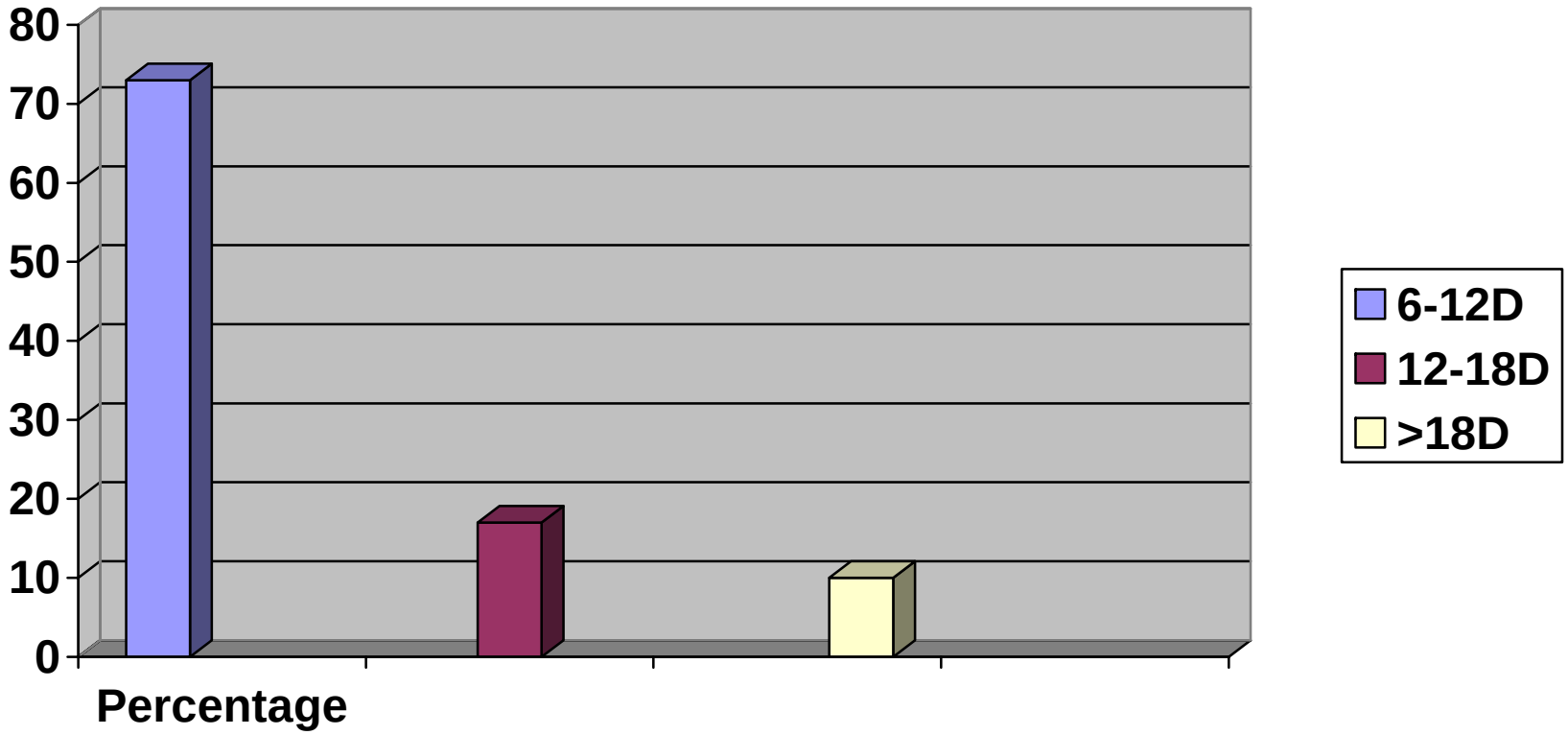




ANALYSIS DEPENDING ON SEX

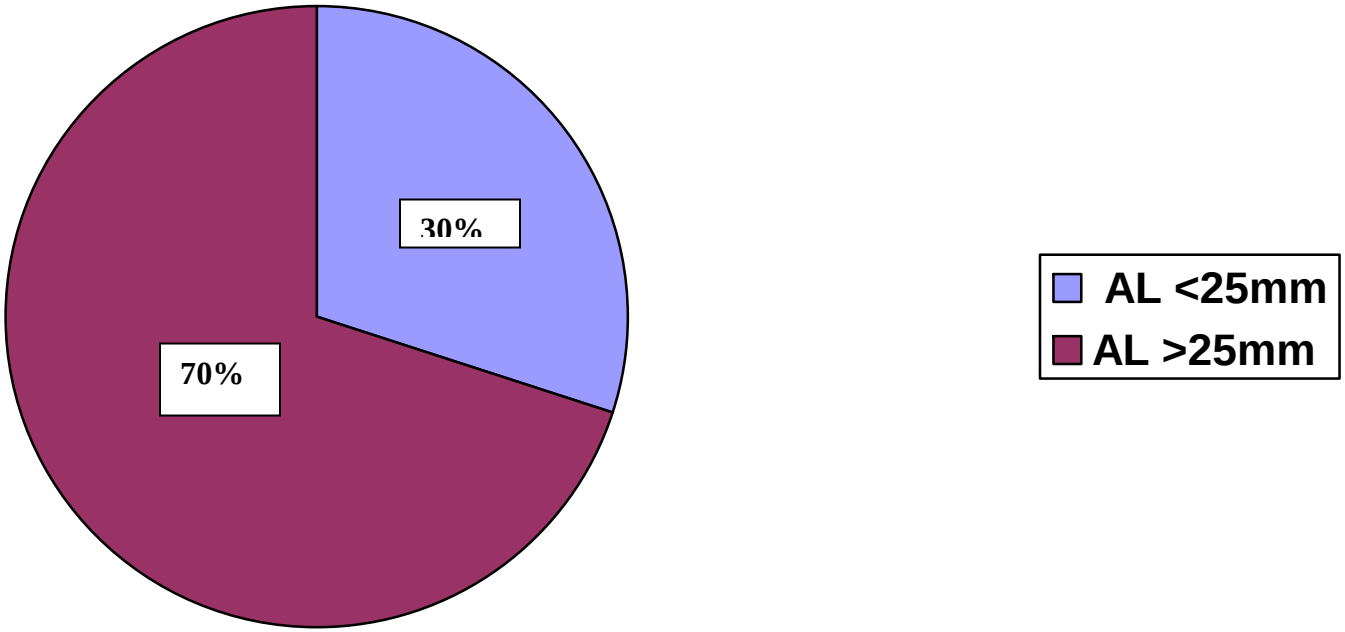


STUDY OF MACULA BY OCT

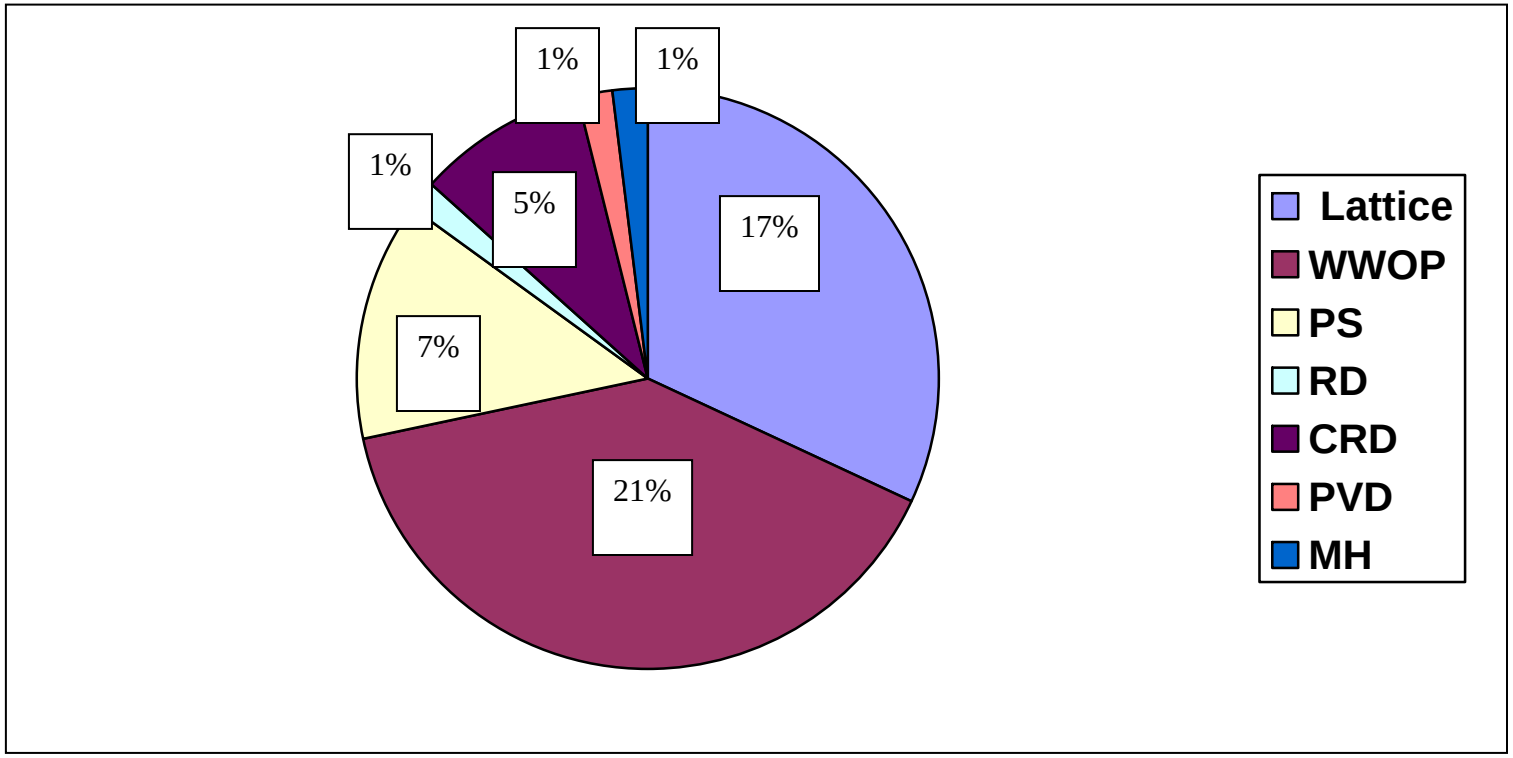


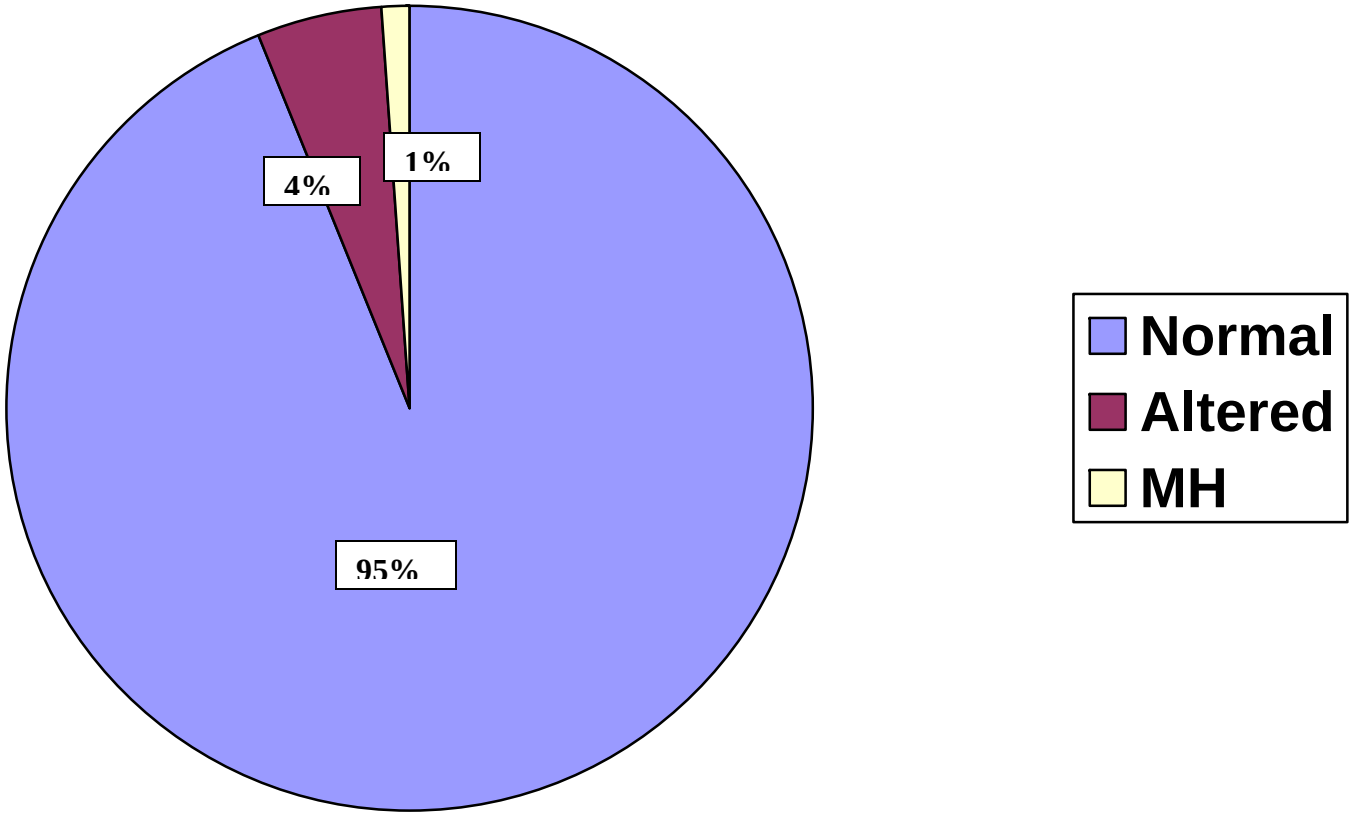
ANALYSIS BASED ON REFRACTIVE ERROR

ANALYSIS BASED ON AXIAL LENGTH



ANALYSIS BASED ON FUNDUS CHANGES





STUDY OF MACULA BY OCT